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Exploring Teaching, Learning, and Instructional Reform in an Introductory Technology Course

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The typical introduction to technology course focuses on helping preservice teachers develop skills for using technology and integrating it into their practice (Downs, 1992; McKenzie, 1994; Niess, 1991; Raiford & Braulick, 1995). Current national standards for technology in teacher preparation also emphasize the importance of developing skills and competencies for using technology (ISTE, 1997; Wiebe & Taylor, 1997). Thus, technology teacher educators tend to see teaching technology-related skills as the primary purpose for the introductory technology course.

However, the preservice technology course has the potential to fill a more central role in a teacher education program. The technology course can provide an authentic context for future educators to examine instructional practices and reflect on their learning as they learn new skills and content. Unlike content-area methods courses—in which preservice teachers often assume they understand the content and are simply learning to teach it—most students *expect* to learn new concepts and skills in technology courses. Course activities can be designed to help students develop technical competence as they explore educational issues in teaching, learning, and instructional reform.

Instructional practice is in a state of transition in American public schools. Ongoing instructional reform efforts promote the use of student-centered cognitive constructivist[1] teaching methods (Cobb, 1994; Jonassen, 1991; von Glasersfeld, 1989; 1995). From a constructivist perspective, the learner actively integrates new information with existing knowledge to construct meaning through experience and develops personal theories about the physical and social world (Piaget, 1970; 1980). Constructivists argue that education involves providing activities and an environment that supports student efforts to construct increasingly complex and sophisticated understandings. Most preservice teachers, however, have a vision of schooling that is grounded in didactic instructional methods. Didactic pedagogy reflects an objectivist tradition that centers on the efficient transfer of knowledge to students and the replication of basic skills (Duffy & Jonassen, 1992; Jonassen, 1991; Lakoff, 1987). Technology provides a versatile instructional tool that can be used to support both pedagogical orientations. Thus, activities in the introductory technology course can be structured to help students compare and contrast these two viewpoints based on their own learning experiences.

The technology course provides a forum for preservice teachers to: (a) reflect on their own learning processes, (b) develop a deeper understanding of learning theory, (c) analyze assumptions underlying traditional and reform-oriented instructional methods, (d) critique the nature of school-based learning experiences, and (e) examine the relationship between learning theory and instructional practice. In the following sections we discuss issues associated with the instructional reform movement, describe factors associated with conceptual change, and present a series of course activities designed to help students explore learning, instruction and reform in our introductory technology course.

INSTRUCTIONAL REFORM

Current trends in education reflect a shift from transmission-oriented didactic pedagogy toward more learner-centered constructivist instructional approaches. These trends are evident in recent curricular reform reports (National Association of Secondary School Principals, 1996; National Council of Teachers of Mathematics, (NCTM) 1991; National Research Council, 1995; National Science Teachers Association, 1990), and increased attention to constructivist learning theories and instructional methods in preservice teacher education courses (Howey, 1996). However, widespread changes in teachers' practices are not proceeding as smoothly or rapidly as reformers had hoped.

Adoption of reform-based pedagogy has been inhibited by teachers' inclination to base their instruction on their own experiences as students in didactic K-12 classrooms (Brookhart & Freeman, 1992; Knowles & Holt-Reynolds, 1991; Lortie, 1975). A self-perpetuating cycle develops in which students who were taught using didactic methods employ didactic methods when they become teachers (Stofflett & Stoddart, 1994). Thus, many teachers who were students in didactic classrooms interpret reform-oriented activities in light of their previous school experiences and adapt constructivist practices to fit with familiar didactic pedagogy (Battista, 1994).

An example of this can be found in the ways that teachers use manipulatives to enhance mathematics instruction. Manipulatives provide tangible objects that students can use to think through abstract mathematical processes and are an important component of reform-oriented mathematics instruction (NCTM, 1989). However, the ways that teachers actually use manipulatives in their classrooms may not be consistent with the constructivist principles that underlie NCTM reforms. For example, a teacher might transform the use of manipulatives into a didactic activity by demonstrating the "correct" way for students to use the manipulatives to solve a problem. Students would be expected to follow the teacher's directions and learn to use the manipulatives to represent or solve a problem in the same way—rather than having an opportunity to use the materials to explore their own thinking and construct personal problem representations and solutions. In this example, the teacher has integrated the use of manipulatives to fit with established didactic practices.

A use of manipulatives that is more consistent with current reforms entails providing materials for groups of students to use for "reasoning together about mathematics" (NCTM, 1991). A teacher who implements the constructivist principles underlying the use of manipulatives could develop an activity that challenges students to develop and demonstrate their understandings of a mathematical concept. The *student* would decide how to use the manipulatives to support their thinking processes and problem-solving strategies. The materials would be used to provide concrete objects to help students explore relationships, test hypotheses, and develop representations of their understandings to be shared and discussed with peers. Although both teachers might claim they are using reform-oriented practices by teaching with manipulatives, only the latter teacher's pedagogy draws on the constructivist principles that drive the reform efforts.

Reform-oriented instruction is not based on the use of certain kinds of materials; rather, it is a fundamental shift in teachers' epistemological and pedagogical orientations. As is the case with manipulatives, computers can be used in ways that are consistent with both didactic and constructivist pedagogies. Teachers will determine how technology gets implemented in the classroom. Despite the assumptions of many policymakers and administrators, there is nothing inherent in technology that ensures reform-oriented uses. To date, many teachers continue to hold traditional beliefs about instruction and have incorporated technology in didactic ways.

Helping preservice teachers change their underlying beliefs about teaching and learning in a teacher education program is a difficult and challenging process. Preservice teachers often lack practical teaching knowledge (Richardson, 1996), making it difficult for them to make connections between learning theories and instructional practices. This problem is compounded by the compartmentalized nature of coursework; learning theory is typically addressed in some courses, pedagogy in others, and few opportunities are provided to explore the relationship between the two. Educational psychology-based learning theory courses often present models of learning as complex and abstract as theories that are divorced from students' personal learning experiences. Thus, it is not surprising that practicing teachers rarely draw on formal learning theories studied in university courses to guide their instructional practices (Pinnegar & Carter, 1990).

On the other hand, many methods courses focus on helping students develop pedagogical skills and strategies. Students may learn to implement constructivist instructional strategies like cooperative learning (Slavin, 1983), reciprocal teaching (Brown & Palincsar, 1985; Palincsar & Brown, 1984), and problem-based learning (Savery & Duffy, 1995), without attending to underlying theoretical considerations. Under these conditions students learn *how* to use constructivist methods without making connections to the epistemological assumptions that underlie their use—increasing the likelihood that students will transform reform-oriented practices to fit with their didactic inclinations. Some activities that can help preservice teachers development include: (a) engaging in active exploration of classroom contexts; (b) providing opportunities for students to reflect on their own beliefs; and (c) encouraging students to consider alternative beliefs and practices (Richardson, 1996).

Experiences as students in constructivist learning environments and opportunities to contrast these experiences with traditional didactic activities can play a central role in helping preservice teachers become effective implementers of constructivist methods (Stofflett & Stoddart, 1994). Preservice teachers need opportunities to examine their own learning under different instructional conditions if they are to understand the relationships among teaching and learning. In effect, engaging in constructivist learning activities can help preservice teachers develop a better understanding of constructivist practices and encourage them to reflect on the nature of teaching and learning.

CONCEPTUAL CHANGE

Preservice teachers instructional beliefs are often firmly entrenched and resistant to change because of their experiences as students in traditional classrooms and a host of structural and contextual factors including (a) standardized tests, curricula, and texts; (b) content-specific block schedules; and (c) pressure to conform to the existing system from administrators and peers (Brown & Rose, 1995; Cohen, 1990; Muchmore, 1994). If teachers are to adopt instructional reforms in ways that truly change their practices, they will need to engage in conceptual change regarding their beliefs about the nature of learning, the role of the student, and their role as teacher.

We turn now to the conceptual change literature to examine the conceptual change process and identify factors that are likely to promote conceptual change. Dole and Sinatra (1998) developed the Cognitive Reconstruction of Knowledge Model (CRKM) to address how conceptual change may occur in instructional situations. They drew on conceptual change models in science education (Posner, Strike, Hewson, & Gertzog, 1982; Strike & Posner, 1992), cognitive psychology (Carey, 1992; Chi, 1992; Seigler, 1996), and social psychology (Cacioppo & Petty, 1982; Petty & Cacioppo, 1986). Key features of the CRKM include (a) the necessity for individuals to be active and engaged in the learning process, (b) the influence of existing conceptions on the change process, (c) motivation for individuals to change their conceptions, and (d) social and contextual factors that can promote change.

Student engagement is a critical element in the conceptual change process (Dole & Sinatra, 1998). High cognitive engagement requires deep processing, elaborate strategy use, and significant metacognitive reflection to connect and compare new information with existing conceptions. Highly engaged learners actively monitor and reflect on their learning—making it more likely they will change their conceptions when necessary. Classroom contexts that promote engagement provide for a high degree of student activity. In such classrooms, students are encouraged to:

1. reflect on how they learn and solve problems;
2. critically think through problems and issues;

3. become more aware of their own beliefs; and
4. monitor the coherence of their beliefs.

(Bereiter, 1990 in Dole & Sinatra, 1998)

Although these conditions may establish an environment that is conducive to examining and evaluating one's beliefs, it is up to students to determine whether, and in what ways, to modify their beliefs.

The strength of an individual's commitment to existing beliefs, and the coherence of those beliefs, has a powerful influence on whether an individual is likely to engage in conceptual change. Traditional beliefs about schooling—developed through years of experience in public school classrooms—tend to be fairly strong and stable. Thus, many preservice teachers need a powerful motivator to prompt them to change their beliefs about the value of using primarily didactic instructional methods. Scientific conceptual change models suggest that dissatisfaction with existing conceptions must occur before individuals will change their beliefs. In other words, some event must challenge the viability of existing beliefs to cause individuals to change their understandings to account for the new information.

When existing conceptions are disrupted, individuals may engage in cognitive restructuring to regain coherence in their beliefs. Cognitive conflict (Festinger, 1962) occurs when an individual encounters new information that is inconsistent with existing conceptions. The resulting *disequilibrium* provides intrinsic motivation for an individual to engage in conceptual change to restore conceptual equilibrium. Regaining equilibrium often requires *accommodation*, which is the process whereby existing knowledge structures are adapted to make sense of conflicting information. This conceptual coherence seeking process, or what Piaget (1971) called *equilibration*, is a basic function of human development. Restructuring one's beliefs, however, is difficult and often creates feelings of uncertainty and discomfort in the learner.

Many students need some form of external influence to get them to put forth the effort necessary for conceptual change. Conceptual change requires a high degree of engagement, considerable effort, and intellectual commitment on the part of the learner. Individuals who are interested in the topic, or have some stake in the outcome, will often be more willing to engage in conceptual change. In addition, some individuals seem to be predisposed to consider changing their beliefs because they enjoy the intellectual activity inherent in the conceptual change process (Dole & Sinatra, 1998).

However, conceptual change does not occur in isolation. Social factors—like promotion by a credible or respected source or peer reaction—

often have a powerful influence on whether an individual will engage in conceptual change. Classroom contexts can be structured in ways that provide opportunities for students to interact with others in ways that promote conceptual change learning. Teachers who want to develop an environment that is conducive to conceptual change are encouraged to:

1. stress cooperation over competition;
2. use intrinsic rather than extrinsic incentives;
3. value mastery over performance; and
4. provide students with moderately difficult (though challenging) tasks.

(Dembo & Eaton, 1997; Stipek, 1996 in Dole & Sinatra, 1998)

These principles, coupled with the earlier suggestions for preservice teacher development and increased student engagement, provided a framework for developing our course aimed at helping prompt students to become critical and reflective learners, and they provide opportunities for them to change their conceptions when appropriate.

In the remainder of this paper, we will describe our introductory educational computing course, that incorporated conceptual change principles and helped students reflect on the relationships among technology, teaching, learning, and instructional reform.

THE COURSE

Two instructional activities were designed to provide students with a common referent for examining didactic and constructivist approaches to instruction. The activities provided a context for teachers to experience different instructional approaches *as a learner* and reflect on strengths and limitations of the two methods. The first activity was a highly structured, teacher directed lesson based on a didactic instructional model. This activity was representative of many school related activities and highlighted some of the problems with a didactic approach. Science education based conceptual change models suggest that preservice teachers will need to experience dissatisfaction with didactic instructional methods before they will be likely to consider alternative perspectives about effective ways to promote student learning.

The second activity was based on a constructivist instructional model and served two purposes: to provide students with experiences as a constructivist learner, and to provide an alternative to the didactic model. This activity required students to assume primary responsibility for planning and implementing a project as they worked cooperatively with peers in a community of learners.

Students completed both activities during the first half of the course. The experiences they gained through completing them served as a referent for discussions and activities that followed. Insights gained through reflecting on relationships among teaching and learning also provided a framework for examining instructional practices in other courses in our teacher certification program and during student teaching.

Didactic Activity

Didactic instruction is grounded in the objectivist notion that reality exists independently of the individual and that the purpose of instruction is to transmit knowledge about that reality to students. Authority lies with teachers who have expert knowledge and skills which can be transferred directly to students and with texts (broadly defined to include printed text, electronic text, various forms of media, etc.). Thus, didactic instruction focuses on replicating expert knowledge. Students learn by internalizing new information and master new skills through repetition and practice. An underlying assumption is that all students in the group will develop knowledge that is identical to the expert's knowledge and that of other learners in the group. Observable outcomes are the hallmark of evaluation. If students can answer questions correctly and/or demonstrate specific skills, then learning is thought to have occurred.

We designed an activity to incorporate didactic principles and highlight some of the flaws in this type of instruction. Students completing the didactic activity did so during the first lab session of the class. They used a detailed script to guide the creation of a homepage using the HyperText Markup Language (HTML). Each student worked individually at a computer with little peer interaction. Students were given a handout that included the exact HTML code that needed to be typed in (in boldface type), and detailed explanations for each line of code. Many students realized they could complete the activity more quickly by typing in the boldface lines without reading the explanations. Their focus was on completing the task rather than understanding what they were doing—an all too common feature of school-based learning activities. The instructors moved around the lab encouraging students to follow directions precisely, praising their efforts, pointing out typos, and providing technical assistance when necessary. Before long, students began calling us over to check their work and tell them if they were "done." If they had carefully followed directions, their homepage was identical to all of the other "correct" homepages in the class. Producing the product was the criteria that determined whether students had completed the project.

A brief multiple-choice test was then administered as a traditional assessment of what had been learned. Test items were taken directly from the detailed explanations on the worksheet which few students had taken the time to read. A review of the right answers followed with considerable praise for those who had chosen correct responses. At this point, many students felt frustrated and disturbed. They had accomplished the task and produced an acceptable product, but the quiz forced them to acknowledge how little they had learned from the activity.

We then engaged students in a class discussion to challenge their assumptions about learning from this typical school-type activity and encouraged them to reflect on their traditional conceptions of instruction. We began by identifying the didactic instructional principals we had used to design, teach, and evaluate the lesson—expert designed outcomes, focus on product, detailed sequential instructions, ongoing praise and feedback, and tests of factual information in which the teacher determines what is important and what counts as a right answer. In general, students acknowledged that the didactic HTML activity was a fairly accurate representation of many of their previous school-based learning experiences.

Some students reported feeling a sense of satisfaction from completing the homepage activity, but expressed frustration with the teaching and learning that had taken place. A few students had experience with HTML and did not believe the activity had helped them increase their knowledge. Others had no experience with HTML and, although they had produced a homepage, did not believe they had learned skills or understood the processes necessary to independently create a homepage, much less teach their future students to do it. Some students confessed to having adopted a "get the assignment done" strategy with little concern for what they had learned. They had hurried to finish the assignments during class time and few had reviewed the handout on their own to make sense of concepts underlying the activity. All admitted that, although the activity had been easy, and completing the project was rewarding in some ways, they had not learned much that would be useful for teaching their future students about HTML or homepage construction.

Further discussion addressed the appropriateness of the activity for the desired outcomes. If the goal for the activity was to help students understand how to create a homepage using HTML, then perhaps didactic methods were not adequate. Didactic methods can be an effective and efficient method for teaching skills and well-defined content; however, we were asking our students to develop their understanding of a complex and ill-defined process. This point lead to a discussion of the types of educational goals that might be suited to a didactic instructional approach, and those that are not.

Although the activity was deemed unsatisfactory for helping students understand HTML, our instructional goal for the course was met. Students were forced to critically examine both the traditional instructional methods used for the lesson and their experiences as learners in this context. We deemed the activity a success because it created dissatisfaction with students' reliance on familiar didactic methods and helped set up the cognitive dissonance that can help prompt conceptual change.

Constructivist Activity

Instruction based on constructivist principles draws on the idea that the individual integrates new information with existing conceptions to make sense of their experiences. Constructivists challenge the objectivist assumption that knowledge can be directly transferred to individuals. Rather, constructivists claim we each construct an individual interpretation of the world because we bring unique background knowledge and sense-making strategies to a learning situation. Instruction is designed to provide opportunities, contexts and support systems that challenge the learner to develop increasingly complex and sophisticated understandings. Students assume responsibility for their own learning as they formulate learning goals, identify gaps and inconsistencies in their understanding, and actively seek and process new information. The individual is viewed as an active sense-maker, driven by curiosity and a desire to understand. Students and teachers work together in a community of learners to challenge and support each other through the learning process. The social context also provides a forum for members of the group to check the viability of their understandings through discussion.

We used a constructivist approach to present and support student development of a second home page. Engaging in these two activities provided a set of common experiences that allowed our students to compare and contrast the two instructional approaches through class discussions and personal reflection activities. Students were able to develop important skills and understandings to improve their knowledge of HTML that built on their experiences with the didactic activity. The focus in the second HTML activity was on understanding HTML and programming rather than simply completing the activity.

The assignment was to develop a homepage around a content area of the students' choosing. In keeping with constructivist principles, students were given considerable responsibility for planning and implementing this project. We referred students to examples of HTML code from the first activity that might help them understand how to accomplish specific tasks. They also learned to search the World Wide Web (WWW) for resources and learned to incorporate source code from on-line web sites into their own homepages. Students were encouraged to share ideas and help their classmates work through problems that arose. The activity was spread over several weeks so students would have ample time to develop a deeper understanding of the homepage development process.

Students were provided with some general criteria to establish the scope and sequence of the activity. Technical support was available from course instructors and lab consultants, but the emphasis was on helping students figure things out for themselves. When students asked questions, we typically responded by modeling the kinds of questions we asked ourselves when we needed to solve our own computer-related problems. This strategy was used to help students become independent problem solvers and encouraged them to think through their problems. Students were also encouraged to share their work and expertise with their classmates and provide suggestions and help for each other. The group developed a mutual support system and continued to help and support each other during the remainder of the course.

Many of our students experienced a good deal of initial frustration while working on the project. They were uncomfortable taking responsibility for their own learning and often asked us to tell them what to do and how to do it. Students became more confident with their abilities to learn independently as their homepages developed. Instructors maintained their roles as resources, guiding students toward potentially fruitful directions and asking questions to challenge thinking, rather than providing answers and giving directions.

When projects were completed, a group evaluation session allowed each student to present their work, explain some of the features they had incorporated, and address questions from their peers. Many had developed a sense of mastery of HTML principles and were eager to share their knowledge with peers. The peer group freely shared ideas, criticism, and suggestions. Most participants indicated that they had learned new strategies and techniques both through completing the assignment and during the peer evaluation sessions.

Homepages became personally significant for students over the course of the project. In contrast to the first HTML assignment, students indicated that they were much more comfortable with their own knowledge about web pages and were more confident in their abilities to teach future students about HTML. Although engaging in a constructivist process to develop a homepage had been extremely time-consuming and, at times frustrating, many students expressed satisfaction in being able to work through the challenges that arose. Students were intrinsically motivated to go beyond the minimal requirements because of their high level of interest and engagement. Some students who had previous HTML experience reported they were intellectually challenged to explore complex web page features that they had previously avoided.

The discussion that followed the evaluation session was structured to encourage students to reflect on the nature of meaningful learning, the role of the learner, and the role of the teacher in an educational context. We discussed the components of a constructivist learning orientation that were apparent in this activity including student agency in designing and carrying out the activity; actively seeking, organizing, and producing information; the social nature of learning; and peer oriented evaluation of the project. Limitations of constructivist instructional approaches were also considered including the extensive time commitment and heightened levels of frustration that students experienced in their struggles to understand.

RELATED COURSE ACTIVITIES

The didactic and constructivist learning activities met several of our course goals. The first HTML activity prompted dissatisfaction with traditional didactic instructional methods and provided a referent for reflecting on limitations associated with this type of instruction. The second activity provided students with a challenging task that prompted them to engage in a constructivist learning activity. Cooperation was encouraged over competition in the HTML 2 activity as students came together as a community of learners. Class discussions and reflective journals encouraged students to consider how they learned and solved problems to complete the activities, how their motivation and goals differed relative to the projects, and the depth of understanding HTML acquired in the two activities. Readings and class discussions about learning theory (that occurred concurrently with the activities) were greatly enhanced because students were able to relate the theory to their own personal experiences. These activities enabled them to examine the relationship between the assumptions underlying the learning theories and the instructional methods used in the class. Subsequent activities built on this foundation.

Reflection Journal

Students used Internet-based newsgroups to systematically reflect on their experiences in the course. They were required to post their own journal entries, and they could also comment on thoughts and ideas presented by their peers in the public newsgroup discussion forum. Writing journal entries helped students become more aware of their own beliefs. Discussions with peers to clarify and expand on their journal entries forced them to monitor the coherence of their ideas.

Field Experience

Students were required to observe in classrooms where technology was used and to conduct interviews with teachers and students during a two-week field experience. They examined the types of software teachers used and the ways that teachers integrated technology with their instruction. They also addressed teachers' beliefs about the role of technology in education and student perceptions about what they were learning. Their own experiences as learners in the HTML activities provided a framework for observations and interviews. Our students were able to analyze the assumptions underlying various instructional methods that teachers used and critically examine the role of technology in the school-based learning experiences they observed. The field experience provided an opportunity for students to actively explore classroom contexts, and to critically think through some of the problems and issues teachers face when they try to infuse technology into their practice.

Software Evaluation

Software evaluation focused on examining the theoretical assumptions about learning that guided the design of different types of programs (e.g., behavioral principles in drill-and-practice and tutorial software, and constructivist components in programs like *SimLife* and the *Geometer's Sketchpad*). Class discussion of software evaluation focused on how some pieces of software could be used to support more traditional didactic instruction (e.g., teacher *PowerPoint* presentations) or a more constructivist orientation (e.g., student *PowerPoint* presentations). Potential learning objectives were examined relative to how various types of software supported different learning goals (e.g., memorizing, problem solving, exploration, etc.). In evaluating software, students used their own learning experiences as a referent for analyzing the nature of learning that would be supported by using different types of software and related technology-based instructional practices.

Software Presentation

A representative from a major software developer was invited to demonstrate his current line of educational software for the class. The class discussion that followed focused on the orientation toward learning and instruction that was presented. Students also discussed the representatives claims about his product (i.e., teachers want skill-based software for math and reading, and that software needs to have sophisticated graphics because ". . . kids love this stuff. The graphics help keep their attention.") Our students were able to separate the educational aspects of the software from the sales pitch, and make judgments about the value of the software based on their understanding of the learning process and instructional principles. Students indicated this activity was a useful exercise for preparing them to think through problems and issues associated with purchasing software. They will be better prepared to make decisions about the types of software they will choose to use as teachers.

Guest Speakers

Several guest speakers were invited to address the class. The educational technology director from the State Office of Education presented information on statewide technology initiatives and the current status of technology in the schools. We also had a principal to come in to discuss the efforts she had made to help teachers integrate technology into the curriculum at her school. Finally, a group of teachers described the ways they used technology as tools to support student projects in their classrooms. Guest speakers constituted credible and respected sources that provided information from several different perspectives that supported the concepts and ideas presented in the course.

STUDENT OUTCOMES

Student feedback at the end of the quarter revealed a range of opinions concerning the value of the course. Most students reported increased motivation and a better understanding of material learned through constructivist methods; however, some students failed to see the relevance of connecting theory to practice. Excerpts from anonymous course evaluations reflected their thinking: "[You] might want to back off from all the psychology and philosophy material. I felt we spent too long on this subject. In fact, very long with respect to this being a *computer* introduction class."[emphasis added] And "I do not feel that this course will help me as a teacher in the area of technology. I believe the behaviorist/constructivist [information] could have been taught in the first couple of weeks, then we could have studied more useful things."

In fact, we only presented (taught) learning theory information during the first two weeks of class, although we often referred back to learning theory concepts during the quarter. Our intent was to draw the learning theory theme through the entire course but some students did not view this as important or necessary. Students were apparently unable (or unwilling) to make conceptual links among the readings and discussions about learning theory, their personal learning experiences, and the instructional practices they had observed. We continue to refine our strategies, activities, message and methods in an attempt to meet these students' needs. We are seeking a balance between learning theory and skill development that will allow more of our students to feel satisfaction with what they take away from the course.

Other students, however, embraced the learning theory component of the class: "This was a great class. It was difficult and challenging which really made me think and examine my own motivations and knowledge." And "The information we learned...was useful to me and helped me understand new concepts. I think I understood the differences between behaviorist and constructivist approaches better than in any other classes where we've talked about these things." These students willingly engaged with the concepts presented in the course and demonstrated a "need for cognition" (Cacioppo & Petty, 1982) in struggling to understand the connections between learning and instruction. Students who were able to make sense of the relationships among the concepts presented in the class and reflect on their own learning experiences clearly benefited from the course. Their understanding of the role of technology in the classroom has made a substantive difference in some of these preservice teachers careers.

Several of our former students have become educational technology leaders in their schools. For example, a student who became a high school science teacher developed his curriculum around activities that required students to develop computer-based reports using presentation software. The high school students searched the Internet to gather information, used word processors, spreadsheets, graphics packages, and other technology tools to organize what they found and developed a presentation to share with peers and parents. Another student was hired as the technology specialist at a local elementary school based on her understanding of the relationship between the teaching, learning, and technology use that she expressed during her interview. The course described here was the only technology class she had taken and she attributed her hire to the concepts she had learned in the class.

CONCLUSION

The activities described here were designed to encourage students to cognitively engage with the content and elaborate their understanding of teaching, learning and instructional reform. We began with a didactic HTML activity that forced students to critically examine their perceptions about traditional school-type activities and the nature of their learning under such conditions. This activity was intended to create cognitive dissonance and prompt students to begin to reflect on their views about teaching and learning. The second HTML activity was designed to help students understand the message underlying current instructional reform efforts—that deep and connected learning occurs when students are actively engaged in the learning process. We challenged students to think through problems and issues, take pride in and ownership of their learning, work cooperatively with peers, and focus on understanding rather than simply completing tasks.

Other course activities provided opportunities for students to begin to look at schools and schooling from a teacher’s perspective, and to critically examine the role of technology in instruction. We provided opportunities for students to monitor and reflect on their own beliefs and consider alternatives through spontaneous conversations with peers, journal writing, and in-class discussions. Students spent time critically examining and participating in real classrooms in ways that enabled them to begin to think about the classroom context as an educator rather than a student. We used our own expertise and drew on practicing teachers and administrators to present a coherent and compelling message about what it means to learn and their roles as future teachers. These aspects of the course helped our students begin to appreciate the complexity of learning to teach.

Our students also developed increased confidence and competence in their ability to use computers by the end of the course. Skills were learned in a highly motivating "project-based learning" context (Blumenfeld, Soloway, Marx, Krajcik, Guzdial, & Palincsar, 1991), in which students took responsibility for determining what they needed to know and how to go about learning it. The constructivist HTML activity provided students with an opportunity to take control of their own learning in a supportive environment.

The activities used to contrast differences between didactic and constructivist instructional methods have changed over time, but the focus on learning and instruction remains. Learning to write HTML code was not critical to the value of the course. Homepages are much easier to create with programs that are designed to accomplish this task, although knowledge of HTML is useful for updating and modifying a web page once it is created. We chose this activity because it was unfamiliar to many of our students—any novel and complex learning activity could be used. Students developed many skills for using technology by the time they had completed the course. More importantly, they learned strategies for acquiring the new skills and knowledge they needed. Students gained the ability and confidence to figure things out for themselves and use resources to get help when necessary.

Students were encouraged to develop a theoretical orientation toward learning that can help guide decisions about effective ways to incorporate technology into their instruction. The learning theory focus of the class provided a framework for (a) examining how different types of computer programs can support different learning goals, (b) how software can be selected to meet instructional goals based on learners' needs, and (c) how to evaluate new educational technologies in the context of student learning. The connections students made between learning theory, their own learning, and educational technology provide a solid experiential base that will serve them well as they enter the teaching profession.

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Note

1. Constructivism will refer to cognitive constructivism for the remainder of the article.